CALIFORNIA
AND
WESTERN MEDICINE

VOL. XXIII JUNE, 1925 No. 6

SPECIAL ARTICLE

THE STATUS OF NEUROLOGICAL SURGERY—TODAY AND TOMORROW

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SURGERY of the nervous system, although one of the newer recognized specialties of medicine, already has made many valuable contributions to medicine, and has accumulated a large amount of literature.

Not every physician has the desire or the training to do neurological surgery, but there is much being done by special students of the subject of great value to all physicians.

It was with the object of bringing out the important developments in the specialty, and particularly the newer knowledge of value to all physicians, that Doctor Naffziger was invited to prepare this essay.—EDITOR.

NEUROLOGICAL surgery has emerged from its infancy to the age where it now makes more than a feeble outcry. Up to the time of the great war, it attracted the attention of but few surgeons. Since that time, and largely due to the experiences obtained in the war, an increasingly large number of well-trained men have devoted their attentions exclusively to it. In a considerable number of medical schools it has assumed its place as one of the major divisions of surgery. A large literature has grown up and a national society has been formed which is composed of men whose major interest is in this field. In this country particularly, the advances in this specialty during the past fifteen years have been remarkably great. These advances have been largely along physiological, diagnostic, and technical lines. It may be of interest to the physician who is not devoting particular attention to this field to review some of the particular conditions and the considerations involved in diagnosis, treatment, and results. It seems safe to prophesy that the next decade will show remarkable advances in many of these lines.

INTRACRANIAL TUMORS

The physician, in thinking of the specialty of neurological surgery, is prone to think of brain tumors as being the particular condition most often seen. It is true that intracranial neoplasms represent the greatest problem in this field, and the most difficult conditions met. Of all organs, the brain, breast, and uterus rank together as common sites for tumors. In the whole range of cranial surgery, however, tumors represent only a part. Recognition of them occurs very much earlier than was the case a comparatively few years ago. During the past two years, at the University of California Hospital, not more than one or two patients have been received who were totally blind at the time of admission. This is a marked contrast to the numerous cases of total blindness common only a few years ago. It is not practicable here to go into a consideration of the various types of tumor pathology which are encountered. There is no pathological classification in general acceptance. It is sufficient here to consider intracranial tumors in two classes, the infiltrating growths, which are principally the gliomas, and the encapsulated growths. In the latter class one thinks particularly of the so-called dural endotheliomas (arachnoid fibroblastomata), the pituitary tumors and the tumors of the cerebellopontile angle. In a strict sense these are intracranial, but not cerebral.

GLIOMATA

The infiltrating growths are numerous, and the gliomas represent nearly one-half of the total number of the tumors. They constitute the most trying group, from the standpoint of both the patient and the surgeon. They are rapid in their progress and, being usually of the infiltrating type, are completely enucleable in only a few instances. Occasionally, radical resection can be performed. Under the gliomas may be included the gliomatous cysts and the cystic gliomas. The cystic change in gliomas is a favorable occurrence. It alters an apparently extremely serious outlook to one which is less grave, and is compatible with continued economic usefulness of the individual and a more or less indefinite span of life. It has not been long since the rather frequent cerebellar gliomas in children were considered a cause for deepest pessimism. A consideration of the results obtained in these cases, however, indicates that a considerable percentage of them, perhaps 20 per cent or thereabouts, pursue a favorable course after pressure effects are relieved at operation. In them the growth becomes entirely stationary, or so slightly progressive that

it seems stationary or a cystic change occurs. Freedom from symptoms over a three or five-year period is common.

PITUITARY TUMORS

The pituitary tumors are being recognized earlier, largely due to the interest and care of the ophthalmologist in carefully taking the fields of vision. Great strides have been made along technical lines in the handling of these conditions. Two main types of operative treatment have developed, namely, the transphenoidal route from below, and the superior route through a frontal or a temporoparietal flap. The superior routes are, of course, the only ones practicable for the supra-sellar tumors, which are fairly common. In recent years there has been a considerable tendency for most neurological surgeons to favor this route also for the pituitary adenomata. It must be said, however, that there are but few operations in neurological surgery which give more satisfactory results than the transphenoidal operation in suitable cases. Those cases with more or less uniform enlargement of the sella and with no other neighborhood signs than defects in the fields of vision of one type or another are the ones usually selected. It is not unusual, however, for this operation to entirely relieve eye-muscle palsies which appear with the enlarging growth. These tumors are of slow development, and the relief obtained is immediate. Many of these cases have been followed post-operatively over a considerable number of years, without a return of any of their symptoms. One of the keenest pleasures is to witness the return of vision and the disappearance of hemianopsias. It is probably not generally appreciated that most individuals with pituitary tumors do not have acromegaly. The acromegalics are in a decided minority. The mortality from transphenoidal operations is low, certainly not more than 10 per cent,[1] and almost without exception post-operative convalescence is easy and rapid. The operative procedure itself places but very little tax on a weakened patient. All patients show the readily recognized signs of an enlarged sella turcica, as shown by the x-ray, and defects in the perimetric fields of vision which usually, at one stage or another, are of a bitemporal type. It is not uncommon, however, for homonymous hemianopsia to be found. The signs of disorder of the ductless glands, while usually present, are seldom the outstanding features of the case or the ones which bring the patient to the physician. Where the tumor has spread far above the diaphragm of the sella, as shown by marked effects on the third and sixth nerves or by pressure on one or another crus, operation by the superior route is necessary. This procedure, of course, permits of a more radical removal of the tumor, but is accompanied by an increased risk over the inferior route. It seems likely that with increasingly early recognition of the pituitary strumas, that the usefulness of the transphenoidal operation will be increased and the necessity for any other more formidable procedure thereby reduced.

ENDOTHELIOMAS

The dural endotheliomas or the arachnoid fibroblastomas, as they are more correctly termed, are among the most favorable types of intracranial tumor. It is not generally enough appreciated, and probably this is due to the unfortunate use of the term endothelioma, that these tumors are circumscribed, do not metastasize and do not recur after complete removal with a reasonable margin of the membranes from which they spring. Moreover, they are of slow growth, usually giving a history of years, and are most common over the vault and on the surface where they are accessible. The brain seems to stand slowly increasing pressure in an astonishing manner and even enormous growths, as one in our series, the size of an orange and weighing 220 grams, may be found without any manifestations of intracranial pressure, such as headaches or choked discs. Indeed they often cause so little disturbance that they may not be recognized until in some late stage they may so interfere with the cerebrospinal fluid pathways as to cause intracranial pressure. The late invasion of the overlying bones of the skull by these neoplasms and the recognition by the patient of a lump on his head as the first sign of tumor is well known.

TUMORS OF THE CEREBELLOPONTILE REGION

Of the tumors of the cerebellopontile angle, the acoustic tumors come first to mind, although this is not an uncommon location for endotheliomas as well as other types of new growth. In the recognition of acoustic tumors, their very slow growth is a characteristic feature and the chronological signs of tinnitus and deafness as the eighth nerve is increasingly involved, followed later by signs indicating pressure upon neighboring structures. Those most commonly involved are the fifth nerve with parasthesiae, numbness, and disorders of the sense of taste and of the seventh nerve with weakness or irritative signs. Pressure on the cerebellum is shown by faults in co-ordination on the same side of the body. In a large percentage of these patients some or all of these symptoms are present without the so-called classical signs of brain tumor, which are, of course, only signs of general rise in intracranial pressure, namely: headache, choked discs, and vomiting. By operation, relief from such pressure signs can be obtained. Complete removal of the growth can occasionally be accomplished. In the remaining ones, partial intracapsular enucleation is done.

Many of the tumors originating within the skull which are overlooked would be recognized, were one to always think of a tumor when they are dealing with any localized, but progressing lesion. Swelling of the optic discs as an indication of intracranial pressure from one cause or another, is widely appreciated. This one sign, whether it comes under the name of papillitis or choked disc, stands out as the most trustworthy and common sign of intracranial pressure. Sufficient experience with the ophthalmoscope to enable one to recognize this condition would save most of these cases from total blindness. Methods of localization of tumors as an aid to clinical neurology have received considerable attention.

DIAGNOSTIC AIDS IN LOCALIZATION

Pneumoventriculography, as introduced by Dandy, has received considerable attention, and is an unquestioned aid in the localization of tumors. It is a method, which, from the reports in the literature, involves a considerable degree of risk, but it is granted that the conditions for which it is done are ones which warrant taking such measures. Ventriculograms have been used in about eighty-five instances in this clinic. One fatality occurred after this procedure, but was due to a late hemorrhage. This procedure has added considerably to our diagnostic ability, but has not given a corresponding gain in the complete removal of tumors such as might be expected. The percentage of tumors which cannot be localized by methods of clinical examination alone has been variously estimated, and no accurate figures upon it are obtainable. It has been placed as high as 50 per cent (Dandy). It is probable that in 20 or 25 per cent an accurate localizing diagnosis cannot be made within a reasonable time without some other aid.

DISPLACEMENT OF THE PINEAL SHADOW

The following procedure, which has been developed in this clinic, is being published elsewhere. It has been of very real value and it involves no risks. In a large percentage of individuals, the pineal gland calcifies under normal conditions. In the lateral radiograms of the skull it is frequently seen. It is developmentally a true midline structure. When radiograms are properly taken in the anteroposterior position it can be determined whether this shadow lies exactly in the midsagittal plane or not. In cases with intracranial pressure, the shifting of the position of this gland can be utilized to great advantage. Any gross lesion associated with an increase in volume in the right cerebral hemisphere will cause this midline structure to shift, and the pineal shadow will be shown to the left of the midline. Likewise a shift to the right occurs with the gross lesion on the left side. When, however, there is a uniform rise of pressure within the skull due to a posterior fossa lesion or one at the base obstructing the cerebrospinal fluid pathways, there is an internal hydrocephalus. The dilatation of the two lateral ventricles is approximately symmetrical, and so in this instance the pineal retains its true midline position. Given an individual suffering from intracranial pressure, after the pineal gland is calcified, one is able to say whether he is dealing with a right cerebral or a left cerebral lesion or an internal hydrocephalus. This simple procedure greatly widens the diagnosis by x-ray and sufficiently localizes many of the otherwise unlocalizable lesions.

THE SPINAL CORD—DIAGNOSTIC AIDS

In the surgery of the spinal cord, several notable additions to our knowledge have occurred within recent years. It has not been so long since Sir Victor Horsley's first successful removal of a spinal cord tumor, in 1888.[2] Spinal cord tumors offer some of the most brilliant results seen in any field of surgery. Fortunately, most of these growths are benign. In the diagnosis of spinal cord compression in the absence of xanthochromia, Ayer's procedure of combined cistern and lumbar puncture has brought great certainty to our diagnosis. Combined puncture of the posterior cistern through the occipito-atlantoid region, if carefully performed, carries but very little risk, and with spinal puncture affords a ready index of the freedom of movement of the cerebrospinal fluid up and down the spinal canal. Alterations in pressure adjustments between these two levels, as shown by manometers attached to the two needles, gives striking evidence. Indeed, since, and because of the knowledge gained from the combined puncture, we are now in a position to obtain much more information from spinal puncture alone. It requires but little experience to note the rapidity with which changes in pressure occur in a manometer attached to a lumbar needle when the patient coughs or strains. Pressure upon the jugulars likewise shows a rapid change in the spinal pressure under normal conditions. Quantitative chemistry of the fluid obtained by cistern puncture, as contrasted with spinal puncture, gives added information. These diagnostic measures give reliable information as to whether there is or is not blockage of the spinal canal. For purposes of locating the level of the lesion, the use of lipiodol should be mentioned. This liquid, a combination of iodin in oil, is slightly heavier than cerebro-spinal fluid and upon introduction into the spinal canal, either by cistern or lumbar puncture, will gravitate to the level of the obstruction with the patient in the proper position, and the presence of the solution at this level will be shown by the x-ray shadow. It has been of value in giving accurate localization when a block is present. Its value is doubtful if no block can first be demonstrated.

CORDOTOMY

For the relief of intractable pain below the level of the upper extremities, cordotomy, or section of the anterolateral tracts of the spinal cord, as recommended by Spiller and Fraser, has come into use. While the applications for it are limited, it adds to our usefulness in certain most distressing conditions. In certain instances where the lease of life of the patient is manifestly short, it may be unwise to resort to a major operative procedure such as this.

ALCOHOL INJECTION

One will occasionally meet with such hopeless conditions as a complete paraplegia from metastatic malignancy to the spine, with terrific pain. When paraplegia is already complete, we have advised the injection of a small amount of absolute alcohol directly into the cord substance, by spinal puncture, just above the level of the lesion. The usefulness of such a procedure is, of course, very limited, but may serve an excellent purpose occasionally.

TIC DOULOUREAUX

Certain neuralgias often demand the attention of the surgeon. Of these, the outstanding one, because of its frequency and severity, is tic douloureux. The diagnosis of this condition is usually simple. The pain most often first appears in the second or third divisions of the fifth nerve, later spreading to the first. Intermissions of months, or even years, are common. The characteristic pain is a terrific lanci-

nating, paroxysmal one of a few moments' duration which leaves the patient fearful and shaken, but entirely free from pain until the next one. There is rarely any continuous pain. Various types, which are comparatively infrequent, but which simulate true tic, have been described by Cushing. The group characterized by pain of this type plus marked contraction in the facial muscles of the same side is of most interest. These are not relieved by the measures which stop the pain in true tic. In true tic douloureux, alcohol injection of the second and third divisions of the nerve, and perhaps also of the supraorbital branch, gives satisfactory, though temporary, relief and, in addition, confirms our diagnosis by showing that blocking of the nerve impulses will give relief. Neurectomies, when applicable, are of the same, but temporary value. It is, of course, a familiar experience to find that numerous other types of pain over the distribution of the fifth nerve area are not relieved by such a procedure. It seems worth while to emphasize the fact that operation, namely, section of the sensory root of the Gasserian ganglion, offers the only permanent relief in true tic douloureux. It does not seem to be widely known that properly conducted operations involve very slight risk, probably not more than 2 per cent. There are few of the major conditions in surgery in which relief is so necessary and in which the risk is so slight.

It seems unfortunate that there is not more familiarity with the clinical picture of this disease and the favorable results of treatment. The character of the pain is usually so distinctive that if it were more generally recognized much preliminary work would be saved. It is a rule for the patients to come after the extraction of all of their teeth and frequently with numerous operations upon the accessory sinuses, all of these things being done in a vain search for the cause of the trouble. There is likewise considerable misinformation as to the aftermath of the operation. The idea seems to be prevalent that facial paralysis and marked deformities are the rule. Facial paralysis is an infrequent complication and as far as we know is never permanent. The reason for its occurrence in occasional instances is not well understood.

OTHER FACIAL NEURALGIAS

Certain other types of facial pain seem to be associated with disturbances in the sympathetic system. Certain painful paresthesiae over the face are relieved by resection of the superior cervical sympathetic trunk.

Glossopharyngeal neuralgia, which is similar in character to tic douloureux, but in which the pain is referred largely to the throat in the region of the faucial pillars and to the ear is a condition less often encountered. It has been emphasized by certain of the French writers, and more recently by Doyle, Lillie, and Adson of the Mayo Clinic [3] in this country. Its diagnosis can usually be made certain by the relief obtained by cocainizing the tonsillar fossa. Relief may be obtained by extracranial avulsion of the nerve or more permanent relief by intracranial section of it.

HYDROCEPHALUS

The treatment of hydrocephalus of infants or of the spinal deformities of infants associated with hydrocephalus still furnishes some of the most difficult problems. In certain types of hydrocephalus, the obstruction to the flow of cerebrospinal fluid may be localized and relieved. In a larger number the process is arrested.

HEAD INJURIES

In the treatment of head injuries, after reviewing the writings of surgeons early in the eighteenth century, and even before this time, one is inclined to feel that but little of value has been added to our knowledge of treatment. In the treatment of fractures of the skull with associated brain damage, the pendulum has swung from time to time from extreme conservatism to radical treatment, such as decompression for all, or nearly all. It seems to be the feeling of a considerable number of the conservative neurological surgeons today that the cases requiring operation are very decidedly in the minority. In the hands of those who are doing most of this work, the percentage of cases operated upon varies between 10 and 25 per cent. The basis of judgment for the cases needing operation is made not only upon the signs of pressure which are present, but upon whether or not they are progressing. The classical signs of acute intracranial pressure are well known. The most reliable ones are slow pulse, increased pulse pressure, and increasing stupor. These signs, however, are the ones presented by a normal brain which is reacting to pressure. The responses of a brain traumatized to various degrees and in various locations are bizarre. They do not always follow this clear-cut picture. It is in these cases that judgment is most difficult. These well-known signs, however, along with such aids as direct measurement of the spinal fluid pressure and observation of the eyegrounds in the more protracted cases, are helpful. In the acute traumatic cases, increased intracranial pressure is always due to an increased fluid content within the skull. This fluid may be present in the form of blood or an increase in cerebrospinal fluid, or through tissue edema resulting from the swelling of the contused brain. It is only by the removal of fluid that pressure can be relieved. The drainage of fluid by one route or another is the aim in any treatment. A decompressive operation which does not drain is usually ineffective. In addition to the removal of blood-clots and of subdural fluid accumulations [4] by drainage through a small decompressive opening, there are other simpler methods which are of value. With large accumulations of free fluid, frequent spinal punctures are used. In true tissue edema, little or nothing is accomplished by such a procedure. The intravenous administration of hypertonic solutions of sodium chloride or Ringer's solution or the administration through the gastro-intestinal tract of magnesium sulphate, supplies other strings to the bow.

INJURY OF THE SPINAL CORD

Injuries of the spinal cord, with paraplegia or quadraplegia, are perhaps the most serious traumatic conditions with which one meets. There is the same

wide variation of opinion in regard to their treatment. Certainly, one can look back upon but few who have definitely been benefited by surgery. Injuries to the contents of the spinal canal below the level of the first lumbar vertebra are among the very favorable ones, and if taken in time much may be accomplished. All injuries of the cauda equina sufficient to give neurological findings below this level merit operative treatment. With the more common injuries just above this level, particularly those at the dorsolumbar junction, one is dealing often with a combined injury of the cord at the conus and an injury of obliquely placed fibers which go to make up the cauda equina. Often in these, little or nothing is accomplished with the cord injury. With the nerves going to the cauda equina, however, it may be possible to afford relief so that there is return of function through those which have their origin from a higher segment and yet are compressed at this point. A return of ability, even to flex the thighs, is of inestimable value to the individuals who are doomed to a hopeless paraplegia. It permits them to sit and even to carry on a certain amount of work. There seems to be no unanimity of opinion, or indeed any greater weight of opinion on one side or the other when comparing the advantages of operative against conservative treatment in injuries to the cord at a higher level. In the early stages it is usually impossible to differentiate between a complete physiological block and an anatomical interruption of the cord. Paralysis from continuing bone pressure is a popular idea with but little to support it. It is probable that the cord injury is an immediate destruction rather than one brought about by the continued pressure. Consequently, little can be expected in the way of operative relief. Compressions from blood clot are likewise unusual, and a suggestion of their presence can usually be obtained by spinal puncture. It frequently happens at operation, even in the presence of a complete paraplegia or quadraplegia, that the cord at the level of the injury appears normal to a casual examination. A small incision, however, into the dorsal columns of such a cord often shows that the entire gray matter is so pulped that it extrudes as a granular tan colored material. Injuries of the cord localized to a comparatively small area are sometimes seen. In these, the evacuation of devitalized material probably allows a greater degree of recovery. Even though most of the explorations are futile and discouragements are the rule, we feel that there are occasional, though rare, unquestioned benefits. A fair number of patients with cord injuries live for long periods. Existences under such conditions would no doubt make all of us wish that we had accepted any chance of benefit, however small. Lack of operative investigation in these patients usually becomes a life-long regret with them when complete paralysis persists.

BIRTH INJURIES

The birth injuries which have resulted in Little's disease or the cerebral spastics of one type or another, are a constant problem. In a few of them early operations are of enormous benefit. In the older children these conditions, many of them hopeless, have been a fertile field for exploitations. Rarely at a late stage can they be benefited by any cerebral operation. Their lesions are destructive and developmental ones. In occasional instances where the process is well localized and where the spasticity has been increasing, or convulsive attacks have appeared, operative intervention may be advisable. Of work, that which has created the most interest is that of Drs. Royle and Hunter of Australia.[5] It seems as yet too early to offer an opinion as to the final status of the procedures which are adopted by Royle, namely, sympathetic ramisection. The cases adaptable to this procedure are limited in number. It is not invariably easy to select them wisely. The operation can be applied only to those in whom a considerable degree of voluntary power is present. Royle's operation has provoked much comment, both favorable and unfavorable. There can be no doubt, however, but that certain very definite results are noted and that in certain of the cases, the procedure has been a decided advantage. It is an operation which permits such voluntary power as is present to be used, but it does not restore voluntary power.

PERIPHERAL NERVES

The surgery of peripheral nerves probably received more of an accretion to our knowledge from the experiences in the great war than any other phase of the surgery of the nervous system. It brought general appreciation of the fact that end-to-end suture of the nerves, without the aid of extraneous substances, was not only the ideal procedure, but was really the only worthwhile one. Autografts or homografts, while they are of great experimental interest and do permit of regeneration through them, do not add sufficiently to the functional improvement to make them worth while. The importance of early exploration and early nerve suture in doubtful cases was one of the most useful lessons. The long waits to determine whether or not regeneration is occurring have been disastrous and have removed the last chance for the patient to gain anything like a satisfactory result. It is probably not so much that regeneration will not occur when suture is performed late, but that the motor apparatus will no longer be in condition and cannot be kept in condition to receive it. While the importance of physiotherapy to prevent the stiffening of joints and proper splinting to prevent overstretching of the muscles were of great value, it became obvious, on the other hand, that the time-honored electrical treatments and massage of muscle bellies did nothing to either hasten recovery or augment it. The experimental research of McLeod and his co-workers at Toronto entirely explodes the idea so long held of the usefulness of faradic and galvanic treatment of the paralyzed muscles.

The scope of neurological surgery permits that mention only can be made of these varied conditions.

Steady advancement on the amelioration or cure of numerous other conditions can but be mentioned. The difficulties in the treatment of brain abscess and how to meet them have received a great share of attention, the amelioration and cure of certain cases of meningitis have all been advances in the handling of acute infections of the central nervous system.

Peripheral nerve surgery in civil life has received attention in the lessening of certain forms of spasticities, in nerve sutures for facial palsy and for palsy of the recurrent laryngeal nerve.

Cervical operations upon the phrenic for intractable hiccough and for immobilization of the diaphragm in pulmonary tuberculosis are receiving consideration.

Resection of the various portions of the cervical sympathetic system or the pain in angina pectoris has been followed in numerous instances by striking relief. It is easily performed under local anesthesia. We have seen patients return to work after long periods of distress and incapacity. It is recognized that such a procedure can have no curative effect on the underlying pathology. Notwithstanding this, the measure of relief has been great enough so that the patients consider it highly satisfactory.

EPILEPSY

Mention should be made of the epilepsies. Certain of the focal epilepsies have a surgical lesion as their basis, and demand surgical attention. In the more common general convulsive states, the convulsions are but a single manifestation of a widespread brain affection. The immediate basis for the convulsions, whether it be circulatory, chemical or from some other cause, is as yet unknown. In such conditions the extreme plight of the patient supplies a field for the overenthusiastic operator. Some epileptics are said to have remained free from convulsions after having had their skulls fractured. Such operators may act only in the role of the traumatizing agents. In the present state of knowledge of the subject, our energies can best be directed toward a solution of the problem rather than to misguided surgical attempts to cure convulsions.

The range of neurological surgery has so widened, and the impetus in its advancement is so great, that the next decade should show many brilliant accomplishments.

The requirements in diagnosis, the character of preparation for such work and the technical procedures themselves are such as to merit specialization in this field. Men interested in it may question the advisability of selecting it on the score that it is too limited. Probably this has always seemed true in contemplating limitation to any specialty. The greater the number of well-trained individuals interested in the same problems, the greater will be the amount of work and the progress in it.

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SURGICAL TREATMENT OF DISEASES OF THE COLON

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I believe we can say that the cecostomy performed in the manner outlined furnishes us one of the best possible means of treatment of many of the severe pathologic conditions of the large intestine, sigmoid and rectum, because it allows us to treat them on the sound surgical principles of rest and cleanliness.

DISCUSSION *by A. B. Cooke, Los Angeles; Emmet Rixford, San Francisco; George K. Knapp, St. Helena Sanitarium; Frank H. Paterson, Santa Ana; M. S. Woolf, San Francisco; Rea Smith, Los Angeles.*

THE colon is an organ for absorption and a receptacle for waste. This dual function requires it to be resistant to the most virulent catabolic poisons and at the same time allow the products of digestion to pass readily. The limiting wall which stands between the living organism on one hand and substances capable of destroying it on the other, is the mucosa. In a state of health it permits the passage of water and nourishment, but obstructs the passage of the common substances deleterious to the organism. Certain accidents of nature occur which alter or destroy this function, and a diseased condition results. We may say, roughly, the severity of the disease depends on the disproportion existing between the pathologic factor on one hand, and the tissue resistance on the other.

The etiology of diseases of the colon can be divided into two general classes: predisposing and exciting. Certain conditions arise which predispose to colonic diseases. Many of these bring it about in a twofold way: (1) By lowering the resistance, and (2) by increasing the virulence of the attacking organism.

Probably the first predisposing factor that should be mentioned is stasis. The second is toxins arising from improper food, faulty digestion or decomposition. The third is systemic diseases interfering with the normal process of absorption and elimination. The fourth, anatomic anomalies, malformations, and distortions.

The exciting causes we may classify in order of their importance: First, bacterial and protozoic infections of the colon. Second, animal parasites. Third, catabolic poisons. Fourth, inflammations and new growths extending from adjacent structures.

PATHOLOGY

(It is not the author's intention to take up the subject of pathology of colitis except in a very general way.)

Pathologic conditions of the colon may attain any degree of severity, from a simple inflammatory condition which will recover spontaneously to a fulminating process leading to extensive destruction. When the latter takes place the faculty of tissue repair is lowered. Healing takes place, if at all, with the formation of scar tissue. First, this causes deformities by contraction and interferes with the normal function of the bowel. Second, the scar tissue does not possess the non-abrasive or the non-corrosive faculty of the normal membrane.

The result is that extensive ulceration heals with great difficulty, and when healing does take place